REMARKS

Claims 12-22 are pending in this application.

Claims 12-22 are rejected.

In a conventional Magnetic Random Access Memory (MRAM) device including a multitude of spin dependent tunneling (SDT) junction memory cells, certain SDT junctions will be unusable. They might be unusable because they are shorted, inadvertently loose data during write operations, or don't switch to the desired magnetization orientations during write operations.

Unusable SDT junctions can reduce the storage capacity of MRAM devices, and increase the complexity of read and write operations. Large numbers of unusable SDT junctions result in the rejection of MRAM devices, and consequently, increase fabrication cost.

The present invention tackles these problems. Claim 12 recites an SDT junction comprising a bottom ferromagnetic layer, an insulating tunnel barrier atop the bottom ferromagnetic layer, and a top ferromagnetic layer atop the insulating tunnel barrier. The bottom ferromagnetic layer has flattened peaks.

A bottom ferromagnetic layer with flattened peaks has been found to significantly reduce or eliminate ferromagnetic coupling. It has been found that a critical flatness is achieved when the peak-to-valley height difference is no more than about one nm. However, peaks flatter than the critical flatness have been found to increase the FM coupling.

In an MRAM device having a multitude of SDT junction memory cells, bottom ferromagnetic layers having flattened peaks provide additional benefits: improving the uniformity of memory cell resistance across the MRAM device; reducing the number of shorted SDT junctions, and allowing insulating tunnel barrier material to be more evenly over the bottom FM layers, thereby allowing the thickness of the insulating tunnel barriers to be reduced without creating pinholes. Reducing the thickness, in turn, reduces the resistance of the SDT junctions, which can reduce power consumption of the MRAM device.

In the non-final office action dated August 25, 2003, claims 12, 16, 21 and 22 are rejected under 35 USC §102(b) as being unpatentable over Gallagher et al. U.S. Patent No. 5,640,343. The reasons for the rejection are unclear and confusing. The examiner argues that the claims are product-by-process claims (due to the limitation "physically flattened peaks") and concludes that a product by process claim "is directed to the product per se, no matter how actually made." It is not clear why this argument was made, since none of the claims are limited to a specific process (e.g., ion etching) for making the flattened peaks.

The examiner also notes that "Applicant has the burden of proof in such cases." However, it is not clear what the applicant must prove.

The reason for the rejection of claim 12 is confusing because the same rejection was addressed in the amendment filed June 6, 2003. In the remarks section of that amendment, it was argued that Gallagher et al. disclose a magnetic tunnel junction 8. The structure of Gallagher et al.'s magnetic tunnel junction 8 is described on col. 4, lines 16-25, and fabrication is described in col. 5, lines 49+. However, Gallagher et al. do not teach or suggest that the peaks of a bottom ferromagnetic layer are flattened or otherwise physically altered.

According to the present office action, Gallagher et al. disclose "the bottom layer is flat (For example: See Figure 1b)." The undersigned reviewed the '343 patent and did not find such a teaching. The undersigned did a search on the word "flat" and did find an occurrence. The undersigned reviewed Figure 1b and failed to see how it illustrates surface roughness.

If the examiner insists that Gallagher et al. disclose a bottom FM layer having flattened peaks, she is respectfully requested to pinpoint the column and line number of Gallagher et al. If the examiner insists that Figure 1b illustrates peaks of a ferromagnetic layer, she is respectfully requested to indicate where those peaks are.

So far, the examiner has yet to find a teaching or suggestion in the prior art for flattened peaks. Therefore, the examiner has not established prima facie anticipation or obviousness. Accordingly, claim 12 and its dependent claims 13-16 should be allowed over the documents made of record.

In the context of claim 12, the limitation "flattened" is an adjective, not a verb. This adjective describes a physical characteristic, not a step in a process. Claims 16 and 22 has been amended to clarify this point.

Claim 21 recites a bottom ferromagnetic layer having physically altered peaks, and claim 22 specifies a type of physically altered peak: a flattened peak. These claims should be allowed since Gallagher et al. do not teach or suggest a bottom ferromagnetic layer having flattened peaks or peaks that have been otherwise physically altered.

Claims 21-22 are further rejected under 35 USC §112, second paragraph as being indefinite because the limitation "physically altered peaks" is not clear.

The specification is also objected to for this reason. The rejection and objection are respectfully traversed. "Physically altered peaks" means peaks that have different characteristics (e.g., valley-to-peak height difference; angle from the top of a grain to an intersection with an adjacent grain) because they were physically altered.

Claim 17 is rejected under 35 USC §103(a) as being unpatentable over Gallagher et al. U.S. Patent No. 5,640,343 in view of Anthony EP0929110A1. This rejection is respectfully traversed for the reasons stated in the amendment filed June 6, 2003. The traverse is repeated here for the examiner' convenience.

> Claim 17 recites an array of memory cells, each memory cell including an SDT junction, each SDT junction including a bottom ferromagnetic layer, each bottom ferromagnetic layer having an upper surface. Each upper surface has a valley-to-peak height variation of no more than about one nanometer.
>
> The office action acknowledges that Gallagher et al. do not teach or suggest a bottom FM layer having a valley-to-peak height variation of no more than about one nanometer.
>
> Anthony does not teach or suggest such a bottom FM layer either. Paragraph 39 of Anthony recites various thicknesses for interface layers of 1 nm or less. The office action appears to assume that an interface layer having a 1 nm thickness would inherently have a valley-to-peak height variation of no more than about one nanometer.
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> However, this assumption is not correct. The interface layer is deposited on a pinned FM layer having a surface roughness. The topography of the interface layer matches the topography of the underlying pinned FM layer. Therefore, it is incorrect to assume that a layer having a 1nm thickness will have a peak-to-valley height variation of 1 nm or less.
>
> Anthony et al. do not teach or suggest a pinned FM layer having a valley-to-peak height variation of no more than about one nanometer.

> The office action has not established prima facie obviousness of claim 17. Still, the application does establish the criticality of this 1 nm height difference: it has been found to significantly reduce FM coupling (see p.8, lines 20-24 of the application).

That was the traverse made in the amendment filed June 6, 2003. The examiner has yet to respond directly to it. The examiner is respectfully requested to respond to this traverse.

The examiner raises the product-by-process argument. However, it is not clear how or why the argument is being applied. It not clear how the limitation "each upper surface having a valley-to-peak height variation of no more than about one nanometer" is a step in a process. In applying the product-by-process argument, is the examiner suggesting that the limitation about the valley-to-peak height variation should be ignored? Explanations are respectfully requested.

The examiner repeats the objections to claims 13 and 19, but does not respond to the traverse made in the June 6. The traverse is provided here for the examiner's convenience:

> Claims 13 and 19 are objected to for not further limiting the claims from which they depend. This rejection is respectfully traversed. These claims recite a range of the grain angles. The criticality of grains within this angle range is, as pointed out in the application, that it is believed to produce fewer magnetic poles at the edges.

That was the traverse made in the amendment filed June 6, 2003. The examiner has yet to respond directly to it. The examiner is respectfully requested to respond to this traverse.

The examiner objects to Figure 2 because "it is not clear where 44 and 42

are supposed to be located. This objection is respectfully traversed. All three reference numerals (40-44) correspond to the black bar, which represents an insulating tunnel barrier and interfacial layers. The specification describes where 42 and 44 are located.

The examiner objects to the drawings because claims 21 and 22 do not show "physically altered peaks." This objection is respectfully traversed. See the description of Figure 5 in the application, which is provided below for the examiner's convenience.

> Figure 5 is an illustration of peak-to-valley height difference on the upper surface of the bottom FM layer 38. A flattened peak is indicated in solid lines by numeral 52, and a portion of the peak removed by ion etching is indicated in dashed lines. A valley is indicated by numeral 54. The height difference between a flattened peak 52 and a valley 54 is indicated by the letter X. Figure 5 is intended merely to illustrate the peak-valley height difference that results from ion etching. It is not intended to provide an accurate depiction of the upper surface of the bottom FM layer 38.

The examiner is respectfully requested to withdraw the rejections of claims 12-22. If any issues remain, the examiner is invited to contact the undersigned to discuss those remaining issues.